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Whither ecosystem health and ecological medicine in veterinary medicine and education

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Introduction

The traditional view that veterinary medicine deals with animal health, public health, and biomedical science, can be reasonably extended to include ecosystem health (1); or put collectively as “one health.” The application of the concept of health, therefore, ranges in scale from individuals to ecosystems. The emergence and importance of ecosystem health has been driven by the realization that dealing with animal and public health must occur in the context of a better understanding of ecosystem processes.

The exponential growth and development of human society and the consequent enormous increase in connectedness among the earth's ecosystems are degrading and compromising natural processes upon which life depends. It has been averred that biological security is the most important societal issue for the 21st century and that the veterinary culture and education have not adapted to this circumstance (2). A much stronger focus on ecosystem health in veterinary medicine would seem to be an essential step in rectifying this situation.

The determinants of health and disease must be understood in the context of nested ecosystems that are connected with growing intensity by social, economic, biological, and physical links (Figure 1). Consequently, dealing with ecosystem connectedness is of paramount importance in the development of science, technology, ethics, and civil organizations needed for ecosystem health management to the extent this is possible, given the enormous complexity of the subject matter.

Developing a culture and educational base for this task is a crucial challenge for society and for the veterinary profession in

playing its part in this wider enterprise. Essentially more attention must be given to ecology (3). For veterinary medicine this can be done by developing ecological medicine (ecomedicine) as an important element in practice and science as its part of society's wider adoption of the ecosystem approach or ecohealth (4). How this might be done is addressed herein.

Defining ecosystem health

The essential definition of health can be applied to all social and geographic scales and has 2 core elements. Health is the capacity 1) to maintain organization (which can variously be interpreted as: freedom from disease; a state of physical, social and mental well-being; productive, sustainable, resilience to cope with stress), and 2) to achieve reasonable human goals. The goals for the health of any species are determined by humans in accordance with whatever goals are considered desirable at the time. The pairing of “ecosystem” with “health” in this case depends on the capacity for balancing sustainability with achieving human goals and makes eminent sense in guiding human interactions with nature. Ecosystem health then is a coherent field of responsibility for veterinary medicine like animal health and public health. All draw on academic disciplines appropriate to the goals at hand.

The process of managing for ecosystem health is pursued by what has been termed the ecosystem approach, or ecohealth (5). This process engages scientists, civil agencies, and the multiple perspectives of stakeholders affected by the goals at hand. It lays the groundwork for environmentally related societal decisions. Many such decisions are difficult because of differences in opinion as to what constitutes a healthful goal.

Veterinarians assist in promoting ecosystem health by their expertise in disciplines that can be applied in what is being termed herein as ecological medicine or “ecomedicine,” essentially the ecosystem approach in a veterinary context. Ecological medicine applies at the scale of individuals, populations, and ecosystems (multiple interacting populations).

Ecomedicine

In the early development of medicine more attention was given to environmental determinants of disease. Their importance was dimmed by the dominance of reductionist science in the past century. The challenge now is to educate the profession to have a more comprehensive appreciation for ecological medicine and its application in the particular fields of practice of its members. Ecomedicine is the art and science used in dealing with the influence of the biophysical and socioeconomic determinants

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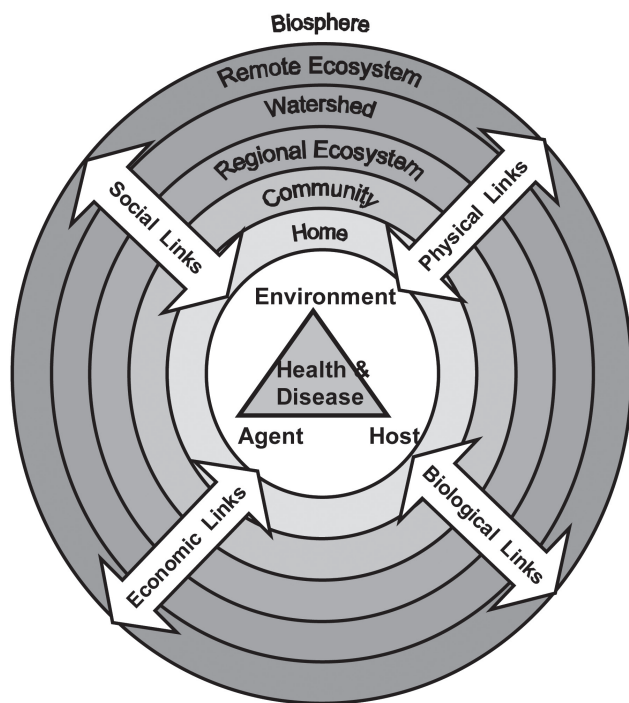


Figure 1. An illustration of the nested nature of ecosystems and the potential of their connectedness to impact the determinants of health and disease.

of health and disease that are linked to the environment at all scales. All veterinarians need to have some understanding of ecological medicine. Some may wish to focus their professional career at the ecosystem level and tailor their education accordingly. Veterinarians must continue to recognize that the profession is part of a much larger transdisciplinary constituency engaged in what is called the ecosystem approach or ecohealth.

The application of ecomedicine in achieving ecosystem health parallels what has been called “conservation medicine.” This term has been promoted by some, among them the organization EcoHealth Alliance (6), which evolved from the Wildlife Conservation Trust established by Gerald Durrell some 35 years ago. While retaining a strong interest in wildlife, it has broadened its interest and defines “conservation medicine” as “an emerging, interdisciplinary field that studies the relationship between human and animal health, and environmental conditions”. While this term has appeal because of its more focused objective, it does not seem to capture the more generic context of ecomedicine which has application in routine veterinary practices. Therefore in veterinary medicine it would seem reasonable to consider conservation medicine as a component of ecomedicine, albeit a major one in which veterinarians play an important role. Ecomedicine in turn can be considered a component of the ecosystem approach or ecohealth.

The influence of scale on the practice of veterinary medicine

Disease problem solving and setting goals for health promotion in practice have evolved more formal or standard methods.

Typically the clinician or investigator uses a “SOAP” approach, an acronym based on 4 major elements namely subjective examination, objective examination, assessment, and plan. This approach can be extrapolated to all scales of veterinary practice and used to identify the particular methods and skills used by practitioners that are sensitive to scale. There are different medical contexts, information needs and types of decisions depending on which scale is involved: 1) individual, 2) population (herd) of a subject species at a single locus, 3) a dispersed population of a species at regional, national or international loci, or 4) multiple populations of multiple species in defined ecosystems. Veterinarians should be conversant with all types and their particular application in their field of endeavor.

This classification of scale framed together with the SOAP format provides a useful approach for analyzing the skills and methods that characterize each type of practice and their relationship to each other (Table 1). Notwithstanding this circumstance the various types of medicine have application at all scales. This framework should be a useful tool in structuring undergraduate, graduate, and continuing education programs that guide the scope of the profession.

Because health involves goals it always has a prospective dimension. The process for determining goals for health is vastly different depending on scale. At an individual level it involves largely consulting the owner(s); it grows increasingly complex as the subject population ranges from being under the control of one person or agency to the point at which the subject population is controlled by regional, national, or international interests; and, even greater complexity where the goals or issues of interest involve multiple populations of different species in ecosystems (including humans) that fall in the jurisdiction of an even wider range of public and private interests. At all scales the veterinarian needs a common core of medical knowledge and skills that are acquired and honed to deal with issues of scale that characterize situations on which they expect to contribute their particular expertise.

The application of ecohealth and ecomedicine

Ecosystem scale

In Canada, the ecosystem approach/ecohealth evolved through the leadership of the International Joint Commission (IJC) and the institutional programs it supported which were given the task of protecting and improving the water quality of the Great Lakes basin ecosystem. The IJC was mandated to develop measurable and agreed to goals and apply administrative, organizational, and scientific resources to coordinate and advocate action among a host of stakeholder interests in their achievement. The outcome of this initiative demonstrated the effectiveness of the “ecosystem approach” and it has been applied more widely, e.g., by forestry and fisheries management, by the International Development Research Centre (IDRC) in international programs under the umbrella of the “ecosystem approach to human health,” and by river watershed conservation organizations. Judging by recent events, governments are moving rapidly to establish land use and/or watershed eco-regions that facilitate the ecosystem approach in managing growth and

Table 1. Illustration of the influence of scale on the kinds of methods and actions, categorized by the conventional SOAP (subjective examination, objective examination, assessment, and plan) approach, practiced by veterinarians in dealing with disease problems and health promotion. The actions described are not necessarily limited to 1 scale

Individual patient — Clinical medicine	Localized population/herd — Population medicine	Dispersed populations of subject species — Regulatory/biosecurity medicine	Multiple populations in ecosystems — Ecological medicine
Subjective History, physical examination	History, herd inspection, sampling	History, biosecurity issues, economic environment; risk identification; food safety/security	Definition of subject ecosystem, its history and stakeholders; jurisdictional issues; risk identification; property rights; societal concerns, e.g. esthetics, biodiversity, zoonoses
Objective Signs, clinical pathology, imaging	Clinical pathology/testing, epidemiology, productivity data	Clinical pathology/testing, epidemiology, economic studies	Indicators, epidemiological GIS, remote sensing, data collection; modeling; risk identification; problem(s) definition
Assessment Diagnosis, problem list, animal welfare	Problem list; productivity potential, animal welfare	Social science, political science selecting disease/health standards, animal welfare, risk and policy analysis, HACCP	Biological and social resilience; ecosystem health goals, scenario, foresight, policy, risk, analysis; multiple perspectives and community values; triangulation; participatory research
Plan Therapeutic and behavioral actions	Management plan; disease control — set producer's (owner's) goals	Policy, health promotion programs, regulatory framework, negotiation.	Set multi-jurisdictional policy goals; design and implement adaptive management plan; monitor ecosystem health indicators

GIS — geographic information system, HACCP — hazard analysis and critical control points.

development in society's best interests (7); or, in other words, managing for ecosystem health. These regional agencies usually have advisory councils that assure community perspectives in decision-making. This move for the widespread creations of jurisdictions that facilitate the ecosystem approach, suggests opportunities for significant public education and employment related to ecosystem health.

These developments portend the emerging need for well-trained transdisciplinary scientists and civic administrators who have a strong background in ecology, complex systems thinking, computer modeling, and a grasp of issues and trade-offs involved in maintaining the health of the various biological components of ecosystems. Veterinarians trained in disciplines that are particularly germane to ecosystem health (wildlife diseases, epidemiology, and toxicology) and in ecomedicine methodology can add essential expertise to human resources devoted to these new societal initiatives.

The single most difficult issue in managing for health at the ecosystem scale is developing a workable governance system that can synthesize plans that are acceptable to a wide spectrum of stakeholders. As always, issues of health involve many players. Consequently the ecosystem approach puts a lot of emphasis on methods to deal with this situation and must be familiar to veterinarians who wish to focus their careers on ecosystem health. It lays the groundwork for arriving at whatever level of consensus is attainable when dealing with complex environmentally related societal decisions.

The application of the ecosystem approach typically includes teams that, depending on the issue, include a range of disciplines and interested parties, for example, political policy specialists, epidemiologists, veterinarians, ecologists, physicians, anthro-

pologists, wildlife disease experts, as well as indigenous leaders. What they have in common is asking questions that are relevant to the "wicked" problems being faced for which there are no easy answers. The process explores the biophysical and socio-economic linkages and includes multiple perspectives of various stakeholders. It is a constant struggle to ensure that various perspectives are heard (including those relevant to species embedded with people in ecosystems and somehow need to be accommodated). This is quite different than the kind of professional expertise demanded in medical and surgical situations, where knowledge, expertise, and hierarchy of command are key.

Some issues or problems can be approached or aided by information technology [e.g., epidemiology, geographic information system (GIS), risk analysis and modeling] or by methods rooted in social science, as a means to illuminate the many perspectives of issue stakeholders. They can range from individual citizens to advocacy groups, various departments of government, non-governmental organizations (NGOs), and private sector firms. Such processes as scenario analysis, foresight analysis, policy analysis, risk analysis, and participatory action research, which are part of the ecosystem approach, are used in this endeavor. Collectively, many of these methods can be considered "prospective science." Since management decisions are future-oriented, the application of the appropriate tools of prospective science makes good sense.

While ecosystem management goals should reflect some measure of consensus, ultimately decisions may have to be conditional and subject to review because of uncertainty in predicting ecosystem functions and/or unintended consequences. The governance mechanism for an ecosystem must be tailored to be adaptive to deal with new realities as they occur.

Dispersed populations scale

The application of ecomedicine in dealing with health and disease issues in dispersed populations through regulatory/biosecurity medicine shares many similarities to ecological medicine at the ecosystem scale. Here there is also a high degree of complexity because of multiple management jurisdictions and vested interests along with a plethora of socio-economic and biophysical linkages as it involves both animals and animal products and a wide variety of policies related thereto, e.g., trade, food safety, foreign animal disease, and animal welfare.

Individual and population scales

In general, existing curricula provide most of the medical knowledge needed to apply ecological medicine. A better appreciation for ecology and systems thinking (8–10) deserves more attention.

Initiatives in ecosystem health in veterinary medicine in Canada

Canada has been a leader in the development of the field of ecosystem health and veterinarians have played a significant role in this endeavor. As a consequence, the veterinary profession in Canada is in a position to capitalize on this experience.

In the 1970's *et seq.* Canadian veterinary colleges laid the groundwork for involvement in the emergence of the field of ecosystem health and ecomedicine by building strength in epidemiology, toxicology, and wildlife diseases. More specific initiatives that fostered the development of the concept of ecosystem health and related thinking began and flourished at the University of Guelph in the early 1990s with Tri-Council and International Development Research Center (IDRC) support for research and for international development, respectively. The University organized the first International Symposium on Ecosystem Health and a workshop on Agroecosystem Health in Ottawa in 1994. The IDRC has continued support at Guelph and elsewhere to the present through its “ecosystem approaches to human health” program.

In veterinary education, the Canadian veterinary faculties cooperatively launched the subject of ecosystem health into the veterinary curricula in Canada with a grant from the Max Bell Foundation in 1993 (11). In the absence of a defined body of veterinary experience and methodology, the founders wisely opted to focus on field investigation of specific ecosystem problems related to animals, and make the subject an elective rotation. It provided for a limited enrolment (4 per faculty) for a 2-week period at 1 of the faculties, and continues to the present.

Given the centrality of wildlife populations (biodiversity) and their diseases (12) in ecosystem health and ecomedicine, it is noteworthy that the Canadian Cooperative Wildlife Health Centre (CCWHC) was established in 1992, and now has nodes at each Canadian veterinary faculty and the Centre for Coastal Health (13). It has established an international reputation for its program and expertise. The CCWHC harbors the recently established McEachran Fund for Ecosystem Health Research (named in honor of Duncan McEachran who played a pivotal role in establishing the veterinary profession in Canada) that

aspires to channel charitable donations from individuals and organizations into research at member institutions. It represents the only point locus for supporting research in all of veterinary academia in Canada with charitable donations.

Another noteworthy development was the establishment of the Centre for Coastal Health (CCH) in 1995 which operates as a self-sufficient veterinary-based research organization in Nanaimo, British Columbia (14). It has a wide-ranging program dealing with “interactions of human, animal and environmental health.” Its association with the new Faculty of Veterinary Medicine at the University of Calgary (UCVM) and the CCWHC facilitates providing DVM and graduate students with practicum experience in ecomedicine through its research programs.

Most recently the UCVM has chosen “ecosystem and public health” as one of its 4 areas of emphasis and has laid out a comprehensive curriculum to address these fields in tandem. This pairing makes sense because public health issues are often embedded in the pursuit of ecosystem health. It could well be that expertise in ecomedicine will enable veterinarians to play a greater role in public health than heretofore. It bodes to give more substance to the “one health” movement.

Employment of veterinarians in ecosystem health

Given the growing implementation of the ecosystem approach in dealing with many environmentally related issues it is logical to expect that expertise in ecomedicine can fit more veterinarians for employment in this endeavor. In the past it appears that veterinarians with expertise in wildlife disease, epidemiology, or toxicology found employment that falls within the domain of ecosystem health. In the future it would be desirable to develop educational programs in ecomedicine that are more specifically tailored to a career in ecosystem health.

Government or government-funded agencies

The promotion of ecosystem health and the application of ecomedicine fall within the mandate of a number of governments or government-funded agencies and will increase. Presently those concerned with public health, natural resources, agriculture, and international development have employed veterinarians with ecomedicine expertise, albeit in small numbers.

Private sector environmental consulting firms

One promising new opportunity should be employment in environmental consulting firms in the private sector. The success of the Centre for Coastal Health is instructive. This independent, not-for-profit science-based organization derives its funding by competing for research grants, and has operated successfully since its establishment.

There is a wide array of environmental consulting firms in the private sector. It seems reasonable to project that veterinarians with expertise in ecomedicine could find employment there if such firms are made aware of their potential. Arranging for student undergraduate rotations and externships and graduate research projects within such firms could be an effective means to this end.

Private veterinary practice

If veterinarians in private practice have the appropriate expertise in ecomedicine they could be employed by government agencies or environmental consulting firms to provide some of the professional services needed to promote ecosystem health in local communities. In rural areas it can be expected that farmers and land owners will be rewarded for managing landscapes to provide essential ecosystem services like biodiversity (15) and water quality in addition to food production.

While ecomedicine could emerge in the long term as a full-time specialty in fee-for-service general, referral, and consultancy practices, that likely will be some years hence. Nonetheless if a "rural community practice" (16) has the ecomedicine expertise to offer services to deal with community problems related to environmental determinants of disease it may not be too optimistic to project this will happen if governments, environmental consulting firms, and the public can be made aware of this potential.

Veterinary education in ecosystem health and ecomedicine

Overview

While the wider profession has a good grasp of how to provide education relevant to its responsibilities for animal and public health, the same cannot be said for ecosystem health, despite Canadian educators being in the vanguard of those addressing this domain.

Ecological or systems thinking and practicing prospective science are critical skills that most veterinarians and many other scientists currently lack. In a world with growing connectedness practitioners should be expected to more fully integrate a systems approach to all determinants of health and disease. Students need to learn a kind of triage and recognize that a particular problem may require ecological as well as medical thinking. For example, an animal may need treatment for parasites (medical thinking) but ecologically the treatment (e.g., ivermectin) may damage the environment. Also, most students are not being educated in how to use social science methods for dealing with complexity and multiple perspectives that characterize practice at larger scales.

While ethical issues have gained increasing importance in veterinary curricula over the past few decades, almost all have been concerned with animal welfare. Ecomedicine builds on the skills developed to deal with these issues and extends them to ask challenging questions related to relationships among individuals, populations and multiple species in ecosystems.

A veterinary student's education should encourage broad critical questioning of the ecological and social-cultural contexts for the disease problems and health promotion issues faced by all veterinarians. Skills in prospective and social science are thus not only basic to veterinary practice, whether in private practice, business, government, and non-government organizations, but they are also elements of good citizenship. Therefore it makes sense to integrate appropriate elements of the social sciences and humanities with the medical sciences in DVM curricula. Case-based instruction, whether in practica or other format would seem a logical means to this end.

Curricula and courses

Curricula for ecomedicine need to provide knowledge and skill for addressing medical issues or problems at whatever scale where environmental determinants are a significant factor. Because ecomedicine is a relatively new branch of veterinary medicine and lacks a substantial literature, a significant share of the curriculum must be case-based. This will assure that the development of didactic material in ecomedicine is guided by experiences gained in dealing with actual ecology-related issues and problems and in understanding their medical dimensions. As such field research and education related practica experiences should be given high priority.

Notwithstanding this reality, it is reasonable to posit that there are subjects/disciplines that deserve attention in more formal courses. Given the current constraints in adding new courses into an already crowded curriculum, the best opportunity for enhancing ecomedicine related expertise is through elective courses and practica rotations that do not have the same constraints. In the longer term the introduction of designated licensure could provide the freedom to develop exciting new opportunities to establish a more comprehensive curriculum for ecomedicine in a DVM program.

It is difficult to make direct comparisons of formal course content related to ecomedicine in existing DVM programs at Canadian faculties because many of its elements are embedded in traditional courses. Such a study would ideally be undertaken by deans responsible for curricula with a view to more precisely defining content that assures appropriate coverage of ecomedicine

Courses cognate to ecomedicine in the DVM program can be grouped into 4 general categories 1) prerequisites, 2) existing coverage, 3) prospective and social sciences, and 4) practica (rotations and externships).

Prerequisites

Prospective DVM students would be well-served by some exposure to courses in relevant ecological and social sciences before entering the DVM program. It is logical to expect that all veterinary students should have had a foundational course(s) in ecology as a pre-requisite for admission to a veterinary medicine program or an opportunity to acquire requisite knowledge as part of the DVM program. Veterinarians need to be sufficiently versed in this subject to be able to communicate and interact effectively with the public, other professionals, and stakeholders in this field.

Existing strength

As in all fields of veterinary medicine, ecomedicine must be built on the strong foundation of comparative medicine that already exists. Developing knowledge in ecomedicine in the context of comparative medicine strengthens this unifying element of the veterinary curriculum. Since veterinary medicine as a profession deals with disease and health management in animals, humans, and ecosystems, it has particular responsibility for developing and synthesizing knowledge of general phenomena that lead to a better understanding of processes of importance

Table 2. Practica rotations in ecosystem health and wildlife diseases presently available to Canadian veterinary students

National elective ecosystem health rotation	All faculties — 2 wk (joint program)
Elective ecosystem health rotations	UPEI — 1 wk; UC — 2 wk
Elective wildlife rotations (which often incorporate ecological considerations)	UG — 1 wk; UPEI — < 3 wk; UM, US — < 6 wk; UC — < 8 wk

in disease causation and health promotion at all scales in all species. Ecomedicine will strengthen the comparative medical links among veterinary medicine, human medicine, and the biological sciences.

Existing curricula already cover a good deal of knowledge appropriate to ecomedicine in courses such as epidemiology, comparative pathology, public health, population medicine, toxicology, and wildlife diseases or touch on its various aspects in most other medical subjects. It seems reasonable to assume veterinary faculties have a resource base that provides opportunities to enhance or adjust content of these courses as prudent to meet needs in ecomedicine if motivated to do so.

Given the recent widespread interest in veterinary faculties in strengthening public health, such an initiative can also provide appropriate opportunities for students aspiring to a career in ecomedicine. One weakness may be that opportunities for challenging and interesting practica in public health are limited. Veterinary expertise in ecomedicine can serve to promote closer cooperation with public health agencies that can be expected to pay more attention to ecosystem health in the future. Indeed veterinary expertise in ecomedicine may be a key avenue to closer cooperation with the public health community.

Prospective and social sciences

Computer, mathematical, quantitative, and qualitative modeling technologies provide important approaches to understanding complex social and ecological phenomena. Therefore, some familiarity with these technologies must be an important element in the education of DVM students who aspire to a career in ecomedicine and significant ecosystem health management. Since modeling technologies are already being applied to management of disease outbreaks, and veterinary expertise in this methodology would seem to be in the early phase of development, they deserve more attention regardless. One need only point to the control of the last foot-and-mouth disease outbreak in the UK where it was averred by some that the models used to develop control measures were disastrously flawed and by others that they were the basis for success.

The methods used for dealing with complexity of health management at larger scales or where there is a multiplicity of perspectives are rooted in social science. Some exposure to social science techniques such as scenario analysis, foresight analysis, risk analysis, focus groups, participatory action research, and comparable methods that lend themselves for use in ecomedicine, would be desirable in the DVM curricula.

Policy is a crucial element in disease control and health management at the scale of dispersed populations and ecosystems, especially in today's hyper-connected world. Nonetheless, veterinary faculties have only recently begun to pay more formal attention to policy in their research and education programs. Every faculty would benefit from a chair in animal health policy.

Practica

With the base of experience in Canadian veterinary faculties of offering elective ecosystem health rotations (Table 2) over the past 15 years it should now be possible to formulate and develop more substantive programs, commensurate with the goal of equipping interested students with a foundation adequate to opt for a career path in ecomedicine or at least to provide ecosystem health management services to clients.

Providing additional practical field experience for students in ecomedicine is the single most important action needed to foster development of this new field. Unless the curriculum for both undergraduate and graduate students includes opportunities to participate in dealing with real world ecosystem health issues it is difficult to see how ecomedicine can become a viable career field in veterinary medicine for more than a few professionals with specialized post graduate training. The ideal venues for undergraduate practica training are those which might provide employment opportunities now and in the future. Environmental consulting companies would seem to be the most promising untapped resource for appropriate practica rotations and externships. If those responsible for veterinary curricula can arrange such opportunities for their students, it will provide hands on experience and at the same time serve to inform consulting firms of potential expertise available from appropriately trained veterinarians. It might be possible to establish "co-op" type programs, but would likely depend on positive experiences with more modest practicum rotations.

In tandem with undergraduate program initiatives faculty can take steps to have graduate students engage in thesis projects developed in cooperation with consulting firms. One can also imagine the development over time of residency type graduate programs where training would include a suite of practical experiences over a prescribed period of time combined with a Masters level research project.

It seems likely that opportunities for practica in ecosystem health in research, government, and international development agencies will increase.

Summary and conclusion

Growing socio-economic and bio-physical connectedness in today's world has put the environmental determinants of health and disease in humans, animals, and ecosystems at the forefront of societal agendas. In a veterinary context this drives the emerging importance of knowledge and skill that can be conveniently classified as ecological medicine or ecomedicine. This domain is logical within a conceptual framework that categorizes veterinary medical practice by scale as a continuum of increasing complexity viz. clinical medicine, population medicine, regulatory/biosecurity medicine, and ecomedicine. Elements of practice in each category have relevance and application across this continuum.

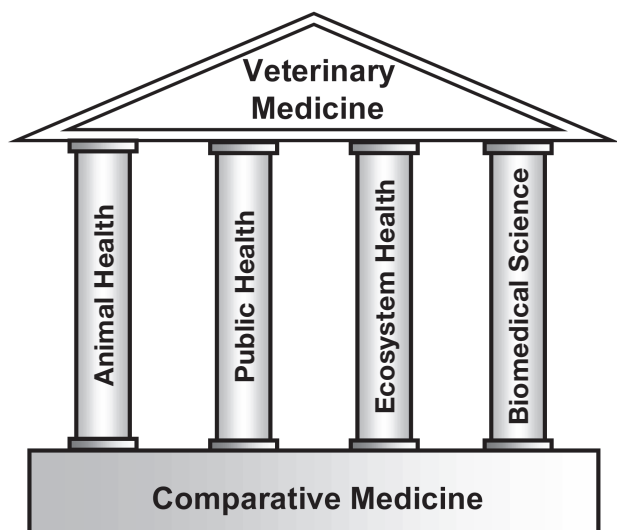


Figure 2. A Greek temple as a metaphor for the essential components of veterinary medicine.

Because ecomedicine has a role at all scales of veterinary practice as well as the centerpiece of a career focused on ecosystem health, veterinary faculties need to assure sufficient attention is given to this domain.

At the undergraduate level it is difficult to see how present veterinary curricula can be modified to provide sufficient allotment of time for courses, laboratories and practicum experiences needed to graduate a student, trained to a desirable level of competence for a career path focused on ecosystem health while still being expected to pass the national certifying examination as currently constituted. Should the profession move to a system of designated licensure, comparable to the situation in engineering education, it would greatly facilitate the evolution of education in ecomedicine. In the meantime it behooves veterinary educators to make the best of the situation at hand and assure all graduates have some appreciation for the subject. Under any circumstance more attention can be devoted to building research programs in ecosystem health.

Given that Canada's new veterinary school, UCVM, has opted to have "public and ecosystem health" as one of its 4 areas of emphasis the time is ripe for the wider Canadian academic veterinary community to collectively review progress and chart more substantive programs in ecomedicine. Ecosystem health must take its place alongside animal health, public health, and biomedical science as one of the pillars of the veterinary profession (Figure 2) that support and define its role in society.

Dedication and acknowledgments

This paper is dedicated to the memory of Bruce Hunter, University of Guelph, and Robert Hudson, University of Alberta, who educated and inspired the authors in helping make the concept of ecosystem health a practical reality. The presentations and discussion at the 2011 CVMA Summit provided many insights. Helpful comments were received from Ted Leighton, James Bellamy, Brian Evans, and Brad Stelfox. Conversations (Nielsen) over many years with Peter Stockdale reinforced the importance of ecology in veterinary education. We appreciate Canada's veterinary schools providing information on student rotations.

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